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ANTHROPOMETRIC AND PHYSIOLOGICAL PROFILE OF ELITE BASKETBALL AND FOOTBALL PLAYERS IN SRI LANKA: THEIR IMPLICATIONS IN PLAYER SELECTION AND TRAINING

ANOJA S. ARIYASINGHE[1]*, A. KARIYAWASAM[1], P. SUBASINGHE[2], A. RAJARATNAM[3]
[1]*Department of Physiology, Faculty of Medicine, University of Peradeniya, Peradeniya, SRI LANKA.*
[2]*Institute of Sports Medicine, Colombo, SRI LANKA.*
[3]*The National Hospital of Sri Lanka, Colombo, SRI LANKA.*
***Email:** anuindresh@gmail.com*

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ABSTRACT

With the ever increasing competitiveness in sports such as basketball and football at national and international levels, coaches are compelled to find means of selecting suitable individual's with high degrees of skill into their teams. In addition to technical skills and tactics, sport performance is also influenced by optimal level of physical, physiological and psychological ability. The purpose of the study was to assess selected anthropometric and physiological profiles of healthy elite football and basketball players of Sri Lankan teams in view to improve the selection criteria of sportsmen. Thirty players from each team (age range of 17-36 years) were evaluated for anthropometric variables namely; standing height, total body mass, arm span, hand span, mid-thigh, mid arm and calf circumferences and fat percentage using standard techniques. Body mass index, lean body mass, fat mass and body surface area were derived using standard equations. Physiological parameters such as resting heart rate, resting blood pressure and peak expiratory flow rate were measured. Variables were compared using independent sample t-test with a level of significance considered as $p<0.05$. The results showed basketball players to have significantly higher values in all measured and derived anthropometric variables except for thigh circumference, which was higher in football players. Means of resting heart rate, systolic and diastolic blood pressure and peak expiratory flow rate were higher among basketball players, but only the latter was significantly higher. Anthropometric and physiological parameters differ considerably between players of the two sports, and thus have implications in player selection and training.

Keywords: *Basketball, football, body mass index, fat percentage, blood pressure.*

1. INTRODUCTION

With the ever increasing competitiveness in sports such as basketball and football at national and international levels, coaches and sport scientists are compelled to find means of selecting suitable individuals with desired qualities and high degree of skill into their teams. In addition to technical skills and tactics, sport performance is also influenced by various factors, including an optimal level of physical, physiological and psychological ability (Kumar, 2014; Mondal & Mridha, 2015; Mohammad, 2015a,b,c). Selection of players for different sports and talent identification of each player help to design and apply new developmental training programs which aim at improvement of a particular sport to global level (Trninić, Papić, Trninić, & Vukičević, 2008).

Anthropometry comprises of diverse simple and reliable techniques that create a thorough understanding of body composition and nutritional status, and also allows the quantification of body size and proportions and evaluation of their changes with time (Nande, Muddafale, & Vali, 2008). Anthropometric parameters depend on genetics, age, sex, socioeconomic status, ethnicity, geographical location, nutritional status and exercise (Ali & Mohammad, 2012; Hussain, Ahmed, Mohammad, & Ali, 2013; Mondal & Mridha, 2015; Mohammad, 2015a,b,c). Adult height and lengths are relatively constant mainly based on a pre-determined genetic potential. However, alterations in relative muscle and fat proportions secondary to exercise and nutritional changes will invariably change weight, girths and body compositional measurements at least to some extent. Conversely, such measurements will help to evaluate nutritional status and also help to highlight the changes with sports training and physical activity. There is a wealth of scientific evidence that shows that body size, shape and composition vary between sport disciplines and even within different playing positions (Anup, Nahida, Islam, &, Kitab, 2014; Eston & Reilly, 2009). Lighter body weight and smaller body size are required in some sports, whereas in others

Correspondence: Anoja S. Ariyasinghe (Ph.D.), Senior Lecturer, Department of Physiology, Faculty of Medicine, University of Peradeniya, Peradeniya, SRI LANKA. Email: anuindresh@gmail.com.

heavier weight and larger body size may be required for optimal performance (Hussain, Mohammad, & Khan, 2011). For example, basketball players are generally believed to need longer upper and lower extremities to aid in catching the ball with jumps, reaching wide during the passes and in throwing the ball into the basket.

The total body weight is the combination of fat mass and lean body mass. Lean body mass includes everything, except body fat, and thus relates to body water, skeletal muscle and skeletal mass. Fat is an essential source of aerobic energy for activities requiring longer duration, and also is closely related to sport performance (Rexhepi & Brestovci, 2010). Nevertheless, excess adiposity can act as a dead body mass in activities where the body must be repeatedly lifted against gravity during locomotion and jumping, thereby decreasing performance and increasing energy demands (Reilly, 1996). Body fat has been observed to negatively correlate with most physical fitness parameters (Nikolaidis, 2013; Maciejczyk et al., 2014).

Cardiovascular changes secondary to exercise includes a reduction in heart rate at rest and at sub-maximal exercise, and an increase in stroke volume, maximal cardiac output and arteriovenous oxygen difference during exercise (Braun,1991). Peak Expiratory Flow Rate (PEFR), the maximal expiratory flow rate achieved during initial stages of forced expiratory maneuver, measures how fast a person can exhale and thus relates to degree of airway obstruction. Strenuous and prolonged strength training has been shown to improve lung capacity and respiratory muscle endurance while better PEFR in footballers compared to basketball players has been attributed to higher running power and speed involved in football (Doherty & Dimitriou, 1997; Mehrotra, Varma, Tiwari, & Kumar 1998).

Only a few comparative studies of physical and physiological characteristics between different national teams or players have been found (Ali & Mohammad, 2012; Hussain et al., 2013; Mohammad, 2015a,b,c Metaxas, Koutlianos, Sendelides, & Mandroukas, 2009; Popovic, Jaksic, Akpinar, & Matic 2013; Rexhepi & Brestovci, 2010) and none in Sri Lanka. Determining these differences between the two sports will help coaches, trainers and sports scientists to select individuals with appropriate physique and talents into the teams. Selecting players for high level competition should be based on specific morphological characteristics, physiological and technical profiles (Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005). These results can be made use in formulating effective and efficient training programs with the limited resources available. Hence, the aim of the study was to assessing and comparing anthropometric and physiological characteristics of top ranking Sri Lankan national level basketball and football players in view of employing this as a guide in player selection.

2. METHODS AND MATERIALS

2.1 Population

This cross sectional study used a convenience sample of 60 healthy, male, national level basketball (n=30) and football (n=30) players, at pre-competition stage. Data was collected at the National Institute of Sports Medicine, Ministry of Sports, Sri Lanka. The participants were initially briefed about the purpose and procedure of the study. Participation was entirely voluntary, and informed written consent was obtained. The study was conducted with approval of the Institutional Ethical Review Committee of Faculty of Medicine, University of Peradeniya, Sri Lanka. A self-administered questionnaire was used to collect information regarding general socio-demographic parameters (age, occupation) and physical training (frequency, duration and nature of training). Those who were acutely unwell were excluded. Measurements were taken according to International Society for the Advancement of Kinanthropometry (IASK) protocol (Stewart, Marfell-Jones, Olds, & Ridder, 2011) by pre-trained research assistants. Privacy was strictly ensured. A single person was assigned to collect data of a particular measurement aiming to negate inter-observer errors. All instruments were calibrated before testing.

2.2 Measurements

2.2.1 Physiological parameters: Cardiovascular physiological parameters such as pulse rate, systolic and diastolic pressures were recorded at rest utilizing a digital sphygmomanometer (Model UA 621, Omron, Japan) in seated position. Peak Expiratory Flow Rate (PEFR) was measured using mini Wright Peak Flow meter following standard techniques. Measurements were taken during the morning hours (8 to 11am) to eliminate diurnal variations in lung functions. The best of three attempts was noted down.

***2.2.2 Anthropometry*:** Body mass was measured using a portable standardized weighing scale (Gima, Italy) to the nearest 0.1kg with the player wearing minimal clothing and no footwear. Standing height was measured using a stadiometer (Gima, Italy) to the nearest 1 cm, using recommended protocols. Triceps, thigh and calf circumferences were measured using a non-stretchable flexible measuring tape to the nearest

1cm, following recommendations of Stewart et al. (2011). Lengths such as arm span, and hand span were measured against a flat surface to the nearest 1 cm according to IASK recommendations (Stewart et al., 2011). BMI and Body surface area (BSA) were calculated according to the following equations:

- BSA (m^2) = (Body mass in kg) 0.425 × (Body height in cm) 0.725 × 0.007184 (Du Bois, Eugene, & Du Bois, 1916).
- BMI (kg/m^2) = (Body mass in kg)/ (Stature in m^2) (Meltzer, Mueller, Annegers, Grimes, & Albright, 1988).

2.2.3 Fat percentage: Skin fold measurements were measured according to IASK recommendations (Stewart et al 2011), to the nearest millimeter on the right side of body at three sites (chest, abdomen and thigh), using Harpenden skin fold caliper (Model CE 0120, China). The average of three readings was taken. Body fat percentage was calculated using body density and Siri's equation (Chan, Leung, Lam, Peng, & Metreweli,1998; Siri,1956). Both fat mass and fat free mass were calculated as described below

- Fat mass (kg) = Fat percentage x total body mass (kg)
- Lean body mass (kg) = Total body weight – fat mass

2.3 Statistical Analysis

Data was entered and analyzed using the 20th version of Statistical Package of Social Sciences (SPSS). Continuous variables were expressed as the mean ± standard deviation. Two tailed independent sample t-test was used for analyzing differences of means of continuous parameters between basketball players and football players. Significance level was kept at $p<0.05$.

3. RESULTS

Thirty basketball and football players were studied. The mean age of basketball players was 24 years ± 4.5 years (range: 18 – 34 years). It was 23 ± 4.3 years (range: 17 – 36 years) in football players.

Table 1: Comparison of physiological parameters between basketball and football players

Physiological parameters	Basketball players(n=30) (mean ± SD)	Football players (n=30) (mean ± SD)	p value
Cardiovascular parameters at rest			
Heart Rate(beats/min)	69.47 ± 7.95	67.27 ± 9.69	0.34
Systolic Blood Pressure (mmHg)	125.10 ±13.06	122.23 ± 9.40	0.33
Diastolic Blood Pressure(mmHg)	71.60 ± 12.39	69.27 ± 8.19	0.39
Respiratory parameters			
Peak Expiratory Flow Rate (L/min)	567.67 ± 66.47	507.67 ± 79.25	0.002*

*P<0.05-significant

As shown in Table 1, basketball players had a higher mean resting heart rate, systolic and diastolic blood pressure than those of football players. However, none were statistically significant. The basketball players exhibited a significantly higher mean PEFR than the football players ($p < 0.01$).

Table 2: Comparison of anthropometric variables between basketball and football players

Anthropometric variable	Basketball players (n=30) (mean ± SD)	Football players (n=30) (mean ± SD)	p value
Total body mass (kg)	79.33±12.87	63.67±8.31	<0.001*
Lengths (cm)			
Standing Height	183.33±8.39	172.83±6.23	<0.001*
Arm span	194.87±20.43	182.73±7.67	0.003*
Hand span	25.23±1.55	23.0±1.23	<0.001*
Mean Circumferences (cm)			
Mid arm	29.80±3.97	26.90± 1.86	0.001*
Mid-thigh	53.80±7.77	50.67± 4.19	0.057
Maximum calf	35.47± 2.42	32.93± 2.84	<0.001*
BMI (kg^{m-2})	23.57± 3.22	21.26± 2.01	0.002*
Body surface area (m^2)	2.01 ± 0.18	1.76 ± 0.13	<0.001*
Skinfold thickness (mm)			
Chest	8.69 ± 4.09	5.73 ± 1.87	0.001*
Abdomen	19.95 ± 10.00	14.53 ± 7.78	0.023*
Thigh	12.33 ± 5.38	10.70 ± 7.30	0.328
Fat percentage (%)	11.61 ± 5.48	8.59 ± 4.15	0.019*
Total fat mass (kg)	9.74 ± 5.83	5.48 ± 2.80	0.001*
Lean body mass (kg)	69.59 ± 8.22	58.18 ± 7.98	<0.001*

*P<0.05-significant

As shown in Table 2, basketball players had significantly higher mean total body mass, standing height, arm span, hand span than footballers. All the three measured circumferences were higher among basketball players. However statistically significant difference was shown only for mid arm and calf circumference. The basketball players also had a significantly higher BMI and BSA compared to the footballers. The basketball players had higher mean skin fold readings in all three sites measured, but statistically significant differences were shown only for chest and abdomen (Table 2). The mean body fat percentage of basketball players was significantly higher than that of football players ($p<0.05$). Mean total fat mass as well as mean lean body mass were significantly higher in basketball players than footballers.

The tallest basketball player in our study measured 199 cm in height and 87 kg in body weight. The tallest football player was 185 cm in height and 75 kg in weight. In addition, ten Basketball players and one football player had a BMI between 25 and 30kgm^{-2} (overweight), and their fat percentage ranged from 14% to 19%. None had a BMI above 30kgm^{-2}. Two footballers (6.6%) were underweight (BMI between 17-18.5 kgm^{-2}).

4. DISCUSSION

Our study, while comparing Sri Lankan national level professional basketball and football players in terms of anthropometry, fat percentage and selected physiological characteristics, has revealed the existence of many differences and a few similarities between players of the two sports.

Mean values of heart rate, systolic and diastolic blood pressures at rest was higher among basketball players than football players although no statistical difference was seen. A similar difference in resting heart rate of both player groups among inter-varsity players was shown by Ghos and Thakur (2014). Significantly higher PEFR in basketball players in our study could be due to their tall stature or better training. This is supported by a study which showed that aerobic exercise, depending on intensity and duration of training, is known to improve PEFR values (Chaitra & Maitri, 2011; Twisk, Staal, Brinkman, Kemper, & van Mechelen, 1998).

Overall, the basketball players were taller, had longer arm span, higher hand span and weighed heavier than the national level football players, which was similar to several other comparative studies (Ali & Mohammad, 2012; Hussain et al., 2013; Mohammad, 2015a,b,c; Metaxas et al., 2009; Popovic et al., 2013; Rexhepi & Brrestovci, 2010). However, the height and weight of our basketball players and footballers was lesser than their international counterparts (Popovic et al., 2013; Rexhepi & Brrestovci, 2010), which could be due to genetically or nutritional factors. The average height of our football players although was lesser than that of the basketball players, it was higher than Sri Lankan population values reported by Ranasinghe et al., (2013). Basketball players being taller and football players being relatively short may provide specific advantages in motor activities. Body height in particular is a characteristic providing an advantage for basketball players to jump high aiming to get the ball in a basket elevated from ground level. However, previous studies on basketball court positions, showed that guards were shorter compared to center and forward positions (Drinkwater, Pyne, & McKenna, 2008). The longer arm span is essentially advantageous for a basketball player during shooting, reach and defense. The increased hand span reflects a wider hand required in grasping, catching, bouncing and throwing the ball. The basketball players had larger physique, bigger maximum calf, mid-thigh and mid arm girths, consistent with findings of Rexhepi and Brestovci (2010).

Furthermore, higher BMI seen among basketball players compared to footballers in the current study was also shown by others (Popovic et al.,2013; Rexhepi and Brestovci (2010). The mean BMI of the study group was comparable to Sri Lankan population figures (Ranasinghe et al., 2013). This is the first Sri Lankan study which assessed body surface area, a crude measure of body size, comparing two sports. The basketball players had higher fat percentage, fat mass and lean body mass compared to the football players, also supporting findings of Rexhepi et al., (2010). They also found subcutaneous adipose tissue to be less dispersed in football players than in basketball players, and stated that it could be due to having different ratios between aerobic and anaerobic demands of different sports (Drinkwater et al 2008; Rexhepi et al., 2010). Yet the fat percentages of both basketball players and the football players in the present study are better compared to Sri Lankan population values (Ranasinghe et al., 2013). Thus it is reasonable to state that our basketball players were muscular as well as fatter compared to the football players. In many competitive sports, lower body fat percentage is related to better performances, probably because low body fat is associated directly with a higher intensity of training (Goran, Fields, Hunter, Herd, Weinsier, 2000; Tanda & Knechtle 2013; Withers, Craig, Bourdon & Norton, 1987). Thus our footballers may be undergoing more strength and endurance training than the basketball players. A low fat percentage helps a footballer with smooth movement required for faster running and dribbling across the field. This study

showed that fat percentage of our football and basketball players is comparable with those of international elite players (Apostolidis, Nassis, Bolatoglou, & Geladas 2004; Casajüs, 2001).

It is thus evident that physique and relative percentages of fat and muscle differ considerably between the two sports. It may have a role in game performance, and thus can be used as one of the criterion in player selection. Modifying modifiable physical characteristics with nutrition and exercise invariably helps the player to reach better standards. It is clear that anthropometric and body compositional features can result from the natural endowment, however physical training and nutritional changes have a major influence. This study clearly shows that basketball players and football players have significant differences in anthropometric parameters. Therefore, assessing anthropometric parameters before selection of players to different sports is of paramount importance to achieve better performance.

5. CONCLUSION

The following conclusions were drawn from our study on the physiological and anthropometric profile of elite basketball and football players in Sri Lanka. Basketball players had significantly higher i) peak expiratory flow rate ii) standing height, weight, arm span, hand span, calf and mid arm circumference iii) fat percentage, fat mass and lean mass iv) body surface area, compared to the footballers. Physique and body composition provide key contribution in the performance of professional players, and thus have implications in player selection and in training.

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